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SETTLEMENT, LITIGATION AND THE ALLOCATION OF LITIGATION COSTS

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SOCIAL SCIENCE WORKING PAPER 564

March 1985

ABSTRACT

We consider a situation in which one party (the plaintiff) has a legally admissible claim for damages from another party (the defendant). The level of damage is known to the plaintiff; the defendant knows only its distribution, which is assumed to be continuous on some range. Before a trial takes place, the plaintiff makes a settlement demand. If the defendant rejects the demand, the court settles the dispute. We characterize the plaintiff's settlement demand policy and the defendant's probability of rejection policy for both separating and pooling equilibria. In the separating equilibrium, the defendant correctly infers the level of true damage from the settlement demand made by the plaintiff. In this case we show that, under risk neutrality, the equilibrium probability of a trial (as a function of true damages) is independent of the allocation of litigation costs. We also analyze the comparative statics of the equilibrium policies and compare them for specific litigation cost allocation systems.

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I. Introduction

In recent years a number of papers have appeared which analyze the factors that determine whether a dispute between two parties will be litigated or settled out of court. This literature dates to work by Landes (1971), Gould (1973), Posner (1977) and ultimately Shavell (1982). These authors analyzed the economic incentives underlying the process of litigation, but never incorporated the strategic aspects of informational asymmetries into their models.

More recently, others have introduced informational asymmetries, and the possibility of strategic behavior based upon them, into models of litigation in various ways. However, in some cases (Salant and Rest, 1982; P'ng, 1983a) the level of settlement is arbitrarily restricted. In others (Bebchuk, 1984) it is the uninformed party which moves first (makes a settlement offer), so opportunities for strategic information transmission are nonexistent. While P'ng (1983b) does allow the informed party to move first (after a suit has been filed), it is the defendant who has the private information. But the uncertainty in P'ng's model concerns the defendant's negligence and thus there are only two potential types of defendant (negligent, or not negligent). Salant (1984) considers the obverse of P'ng's model, giving the plaintiff both private information and the opportunity to make a settlement demand. The uncertainty in Salant's model concerns the

1. We would like to thank Joel Sobel for helpful discussions. His comments greatly improved an earlier draft of this paper. This work was supported in part by National Science Foundation Grant No. SES-8315422.

level of damage inflicted on the plaintiff. Since it is natural for this variable to take on a range of money values, the problem is much richer than that of P'ng (1983b). It is Salant's model to which ours is most closely related (in fact, our model is essentially an extension of his to the continuum case), and we will comment in more detail on this in the conclusion.

Suppose that one individual (the defendant) commits an unlawful act which harms another individual (the plaintiff). The plaintiff has in principle a legally admissible claim for compensation from the defendant, but the amount of damage inflicted is known only to the plaintiff. The individuals can either agree between themselves to a settlement or they can use a third-party dispute resolution mechanism; for example, a court. During bargaining, information of a variety of sorts may be exchanged. The plaintiff may inflate his or her claims regarding the level of damage and the defendant may use discovery rules in an effort to ascertain the level of damage. We assume that at the end of this process there is still some residual uncertainty on the part of the defendant about the level of true damages; that is, the defendant knows only that true damages are confined to some range and are distributed according to some frequency distribution. We assume that at the conclusion of the bargaining process the plaintiff makes a final settlement demand to the defendant. If the defendant rejects the plaintiff's final demand, the dispute is settled by the court. Using the court to resolve the dispute is costly to both the defendant and the plaintiff (in terms of time, legal fees, etc.), and may be subject to error. The court may also award the plaintiff punitive damages. The problem is to characterize equilibrium policies which specify, for the plaintiff and the defendant, respectively, a settlement demand for each possible level of damages, and a probability of rejection for each possible level of settlement demand.

In Section II we present our formal model and describe equilibrium policies under quite general assumptions regarding who bears the burden of litigation costs. Our definition of equilibrium is based on Kreps and Wilson's (1982) sequential equilibrium; it is essentially a signalling equilibrium of the type studied by Spence (1974) except that out-of-equilibrium beliefs are made explicit. We have applied the same equilibrium concept to the analysis of tax compliance (Reinganum and Wilde, 1984) using a model which has a structure similar to the settlement/litigation model introduced in Section II. We focus primarily on separating equilibria, in which the defendant can identify the plaintiff's type (the level of damages) by the size of the settlement demand he or she makes. We derive closed-form characterizations of the settlement demand policy and the probability of rejection policy. It is surprising that in the separating equilibrium, even though the settlement demand policy and the probability of rejection policy depend on the allocation of litigation costs, the likelihood of trial as a function of the level of damage (that is, the composition of the settlement demand policy and the probability of rejection policy) is independent of the allocation of litigation costs. We also show that while the likelihood of trial increases with the level of damage and decreases with an increase in either party's litigation costs (as expected), it increases with the rate of punitive damages and the probability of a judgment in favor of the plaintiff, despite the fact that it is the defendant who decides whether a dispute goes to trial.

In Section III we compare specific allocations of direct litigation costs (e.g., legal fees as opposed to time). We consider four systems as discussed by Shavell (1982): the American system (in which each party bears its own costs), the British system (in which the loser bears all the costs),

and systems favoring the plaintiff and the defendant, respectively. Under all four of these systems, the settlement demand increases with the level of damage, the defendant's litigation costs, the rate of punitive damages and the probability of a judgment in favor of the plaintiff. The settlement demand is independent of the plaintiff's litigation costs under the American system and the system favoring the plaintiff, and increases with the plaintiff's litigation costs under the British system and the system favoring the defendant. Under all four systems, the probability of rejection (as a function of the settlement demand) increases with the settlement demanded, and decreases with an increase in either individual's litigation costs, the rate of punitive damages and the probability of a judgment in favor of the plaintiff.

We conclude the paper in Section IV, where we summarize our results, compare them with those of the existing literature, and discuss interesting extensions and variations on the basic model.

II. The Model

We assume that an individual (the defendant) commits an unlawful act which harms another individual (the plaintiff). The amount of damage inflicted, d , is known only to the plaintiff. The defendant knows only that such damages usually lie within some interval $[\underline{d}, \bar{d}]$ and occur with some frequency distribution $F(\cdot)$. If the plaintiff makes a claim which is resolved by a court, there is an exogenous probability, $1 - \pi$, that the court will find in favor of the defendant. If the court finds in favor of the plaintiff, which happens with probability π , it assesses the extent of true damages, d , and orders compensation. This compensation may include punitive damages. so that the judgment awarded the plaintiff is $d + td$, where t is a measure of the

extent of punitive damages. The plaintiff has the option to offer to settle out of court for an amount S . We allow S to take on any value in $(-\infty, \infty)$ although one would expect it to be nonnegative. If the defendant rejects the plaintiff's settlement demand, the dispute is resolved by a court or other third-party dispute resolution mechanism.

We assume that both the plaintiff and the defendant are risk-neutral wealth maximizers. Let w_i , $i = P, D$ represent initial wealth and let c_i , $i = P, D$ denote litigation costs, for the plaintiff and the defendant, respectively. In order to compare alternative systems for allocating litigation costs, we define the following parameters: k_{ij} for $i, j = D, P$ denotes the litigation costs borne by agent i when agent j wins the case. Since the costs $c_D + c_P$ must be paid, regardless of who wins, it is necessary that $k_{DD} + k_{PD} = k_{PP} + k_{DP} = c_D + c_P$. Then we can write expected net wealth to the plaintiff in the event of a trial as $w_P - d - \pi(1+t)d - \pi k_{PP} - (1-\pi)k_{PD}$. If the plaintiff's settlement demand S is accepted, net wealth to the plaintiff is simply $w_P - d + S$. Similarly, expected net wealth to the defendant in the event of a trial is $w_D - \pi(1+t)d - \pi k_{DP} - (1-\pi)k_{DD}$, and if the defendant pays the settlement demand S , net wealth is $w_D - S$. We assume that $\pi(1+t)\underline{d} \geq \pi k_{PP} + (1-\pi)k_{PD}$, so that a plaintiff is always willing to use the court system, even if damages are minimal.

A strategy for the plaintiff is a function $S = s(d)$, which specifies a settlement demand for each possible level of damages. A strategy for the defendant is a function $p = p(S)$ which specifies the probability that the defendant rejects the demand S . Because the defendant does not know the true damages d , he or she must form some conjectures or beliefs about d based on the settlement demand S . Let $\mu(\delta|S)$ denote the defendant's assessment that

$d \in \delta$ given that a demand of S was made, where $\delta \subseteq [\underline{d}, \bar{d}]$. We require that $\mu([\underline{d}, \bar{d}]|S) = 1$; that is, the defendant cannot assign to any demand a type of plaintiff which does not exist. Given these beliefs, the expected net wealth for the defendant when a demand S is made, and he rejects it with probability ρ , is

$$\Pi_D(S, \rho; \mu) = \rho[w_D - \pi(1+t)E_\mu(d|S) - \pi k_{DP} - (1-\pi)k_{DD}] + (1-\rho)[w_D - S],$$

where $E_\mu(d|S)$ denotes the expected value of damages d , given that S was demanded, under the beliefs μ . Net wealth for a plaintiff who has suffered damages d , demands S to settle, and takes as given the strategy $p(S)$ of the defendant, is

$$\Pi_P(d, S; p) = p(S)[w_P - d + \pi(1+t)d - \pi k_{PP} - (1-\pi)k_{PD}] + (1-p(S))[w_P - d + S].$$

Definition 1. A triple (μ^*, p^*, s^*) is an equilibrium if (a) given μ^* , $p^*(.)$ maximizes $\Pi_D(S, \rho; \mu^*)$; (b) given p^* , $s^*(.)$ maximizes $\Pi_P(d, S; p^*)$; and (c) if $s^{*-1}(S) \neq \emptyset$, then $\mu^*(\delta|S) = \mu_F(\delta \cap s^{*-1}(S)) / \mu_F(s^{*-1}(S))$ for all $\delta \subseteq [\underline{d}, \bar{d}]$, where $\mu_F(\delta) = \int_\delta dF(d)$.

This definition allows pooling equilibria, in which $s^{*-1}(S)$ is set-valued. We will focus initially on separating equilibria. Therefore we define point beliefs $d = b(S)$, which assign a unique type of plaintiff (level of damages) to each settlement demand. Then we can rewrite the defendant's expected net wealth as

$$\Pi_D(S, \rho; b) = \rho[w_D - \pi(1+t)b(S) - \pi k_{DP} - (1-\pi)k_{DD}] + (1-\rho)[w_D - S].$$

Definition 2. A triple (b^*, p^*, s^*) is a separating equilibrium if (a) given

b^* , $p^*(.)$ maximizes $\Pi_D(S, \rho; b^*)$; (b) given p^* , $s^*(.)$ maximizes $\Pi_P(d, S; p^*)$; and (c) $b^*(s^*(d)) = d$ for all $d \in [\underline{d}, \bar{d}]$.

A candidate for equilibrium can be constructed as follows. Consider first the decision problem facing the defendant. Clearly Π_D is differentiable and concave in the defendant's decision variable ρ . Differentiating Π_D with respect to ρ gives

$$\partial \Pi_D / \partial \rho = -\pi(1+t)b(S) - \pi k_{DP} - (1-\pi)k_{DD} + S. \quad (1)$$

This expression is independent of ρ ; if it is positive, $p^*(S) = 1$; if it is negative, $p^*(S) = 0$; if it is zero, then the defendant is indifferent about the value of $p^*(S)$. Consider initially an interior equilibrium, in which $p^*(S) \in (0, 1)$. Then $s^*(d)$ must satisfy $\partial \Pi_D / \partial \rho = 0$, which, after incorporating the consistency condition that $b^*(S) = d$, yields

$$s^*(d) = \pi(1+t)d + \pi k_{DP} + (1-\pi)k_{DD}. \quad (2)$$

However, the settlement demand function $s^*(d)$ must also maximize the plaintiff's expected profit, given $p^*(S)$. If $p^*(S)$ is twice differentiable, then $s^*(d)$ must solve

$$\partial \Pi_P / \partial S = p^{*'}(S)[\pi(1+t)d - \pi k_{PP} - (1-\pi)k_{PD} - S] + 1 - p^*(S) = 0, \quad (3)$$

and satisfy the second-order necessary condition

$$\partial^2 \Pi_P / \partial S^2 = p^{*''}(S)[\pi(1+t)d - \pi k_{PP} - (1-\pi)k_{PD} - S] - 2p^{*'}(S) \leq 0. \quad (4)$$

Combining equations (2) and (3), and recalling that $k_{DD} + k_{PD} =$

$k_{PP} + k_{DP} = c_D + c_P$, yields a first-order linear differential equation which $p^*(S)$ must satisfy.

$$-p'(S) - p(S)/(c_P + c_D) - 1/(c_P + c_D) = 0 \quad (5)$$

Equation (5) has a one-parameter family of solutions

$p(S) = 1 + \alpha \exp\{-S/(c_P + c_D)\}$. As is shown in the Appendix, the appropriate boundary condition is $p(\underline{S}) = 0$, where $\underline{S} = s^*(\underline{d}) = \pi(1+t)\underline{d} + \pi k_{DP} + (1-\pi)k_{DD}$ is the settlement which would be demanded by the least-damaged plaintiff. This yields the probability of rejection function $p(S) = 1 - \exp\{-(S - \underline{S})/(c_P + c_D)\}$.

We also need to specify beliefs about settlement demands outside the range $[\underline{S}, \bar{S}]$, where $\bar{S} = s^*(\bar{d}) = \pi(1+t)\bar{d} + \pi k_{DP} + (1-\pi)k_{DD}$. Although we will argue that virtually any out-of-equilibrium beliefs are permissible, we find the following beliefs both simple and compelling: if $S < \underline{S}$, let $b^*(S) = \underline{d}$ and if $S > \bar{S}$, let $b^*(S) = \bar{d}$. That is, when a demand is made which ought not to be made by any plaintiff in equilibrium, the defendant believes the plaintiff to be that plaintiff whose equilibrium demand is closest to the one which was made.

Theorem 1. The following triple (b^*, p^*, s^*) is the "unique" separating equilibrium: define $\underline{S} = \pi(1+t)\underline{d} + \pi k_{DP} + (1-\pi)k_{DD}$ and $\bar{S} = \pi(1+t)\bar{d} + \pi k_{DP} + (1-\pi)k_{DD}$.

$$(i) \quad p^*(S) = \begin{cases} 1 & S > \bar{S} \\ 1 - \exp\{-(S - \underline{S})/(c_P + c_D)\} & S \in [\underline{S}, \bar{S}] \\ 0 & S \leq \underline{S} \end{cases}$$

$$(ii) \quad s^*(d) = \pi(1+t)d + \pi k_{DP} + (1-\pi)k_{DD}, \text{ for } d \in [\underline{d}, \bar{d}];$$

$$(iii) \quad b^*(S) = \begin{cases} \bar{d} & S \geq \bar{S} \\ [S - \pi k_{DP} - (1-\pi)k_{DD}]/\pi(1+t) & S \in [\underline{S}, \bar{S}] \\ \underline{d} & S \leq \underline{S} \end{cases}$$

The word "unique" is flagged in Theorem 1 for the following reason.

It is clear that we could allow arbitrary beliefs for demands outside the interval $[\underline{S}, \bar{S}]$, since any beliefs μ would have an expected value $E_\mu(d|S)$ between \underline{d} and \bar{d} . Demands $S < \underline{S}$ would be accepted with probability 1 under the belief that $b(S) = \underline{d}$, and would be even more attractive to the defendant if he or she believed that the expected damages were greater than \underline{d} . Similarly, demands $S > \bar{S}$ will be rejected with probability 1 under the belief that $b(S) = \bar{d}$, and would be even less attractive if expected damages were believed to be smaller. Thus there is actually a unique "equivalence class" of separating equilibria, in which out-of-equilibrium beliefs may differ, but the policies $p^*(.)$ and $s^*(.)$ are the same.

The equilibrium strategies are displayed in Figure 1. The proof of Theorem 1 is tedious and can be found in the Appendix. However, an intuitive justification of the boundary condition $p^*(\underline{S}) = 0$ is as follows. The policy $p^*(S)$ must be increasing; since the settlement demand function reveals true damages d , larger settlement demands are less attractive to the defendant. Thus any discontinuities in $p^*(.)$ must consist of upward jumps. But an upward jump at any demand $S \in [\underline{S}, \bar{S}]$ implies that the plaintiff d for whom $s^*(d) = S$ would strictly prefer to demand $S - \epsilon$ for sufficiently small ϵ . The upward jump in $p^*(.)$ at \bar{S} is permissible because in equilibrium there are no plaintiffs for whom $s^*(d) > \bar{S}$, and consequently no plaintiffs are tempted to deviate from their equilibrium demands.

The equilibrium strategies will obviously depend upon the allocation of litigation costs, and this dependence is examined in Section III for

several specific cost allocation systems. However, ultimately we want to compare the equilibrium probability of trial (for any given level of damages d) under alternative legal systems. The equilibrium probability of trial as a function of the damages d is $\hat{p}(d) \equiv p^*(s^*(d))$. The simple way in which p^* depends on S and the linearity of s^* in d combine to give

$$\hat{p}(d) = 1 - \exp\{-\pi(1+t)(d - \underline{d})/(c_p + c_d)\}. \quad (6)$$

Corollary 1. The equilibrium probability of trial is independent of the allocation of litigation costs.

This surprising result contrasts sharply with those of Shavell (1982), P'ng (1983b) and Bebchuk (1984), all of whom conclude that when both plaintiff and defendant are risk-neutral the allocation of litigation costs materially influences the equilibrium probability of trial. Other properties of $\hat{p}(d)$ will be described in Section III.

Besides the separating equilibrium described in Theorem 1, there may exist a continuum of pooling equilibria. Most depend upon "perverse" out-of-equilibrium beliefs; these are characterized in the Appendix. But one pooling equilibrium deserves some discussion: suppose that $\bar{d} - E(d) \leq (c_d + c_p)/\pi(1+t)$, where $E(d)$ is the expected value of d before any settlement demand is made (the prior or unconditional mean of d). If the defendant believes that the settlement demand contains no information (that is, the beliefs μ are such that $E_\mu(d|S) = E(d)$ for all S), then the equilibrium settlement demand policy is $s^*(d) = \pi(1+t)E(d) + \pi k_{DP} + (1-\pi)k_{DD}$ for all $d \in [\underline{d}, \bar{d}]$, and the equilibrium rejection policy has $p^*(S) = 0$ for $S \leq \pi(1+t)E(d) + \pi k_{DP} + (1-\pi)k_{DD}$ and $p^*(S) = 1$ for

$S > \pi(1+t)E(d) + \pi k_{DP} + (1-\pi)k_{DD}$. In this case the defendant simply ignores any information which might be contained in the settlement demand; all plaintiffs are treated as if they suffered average damages. The condition $\bar{d} - E(d) \leq (c_d + c_p)/\pi(1+t)$ guarantees that all plaintiff types would prefer such a settlement to trial, and that the defendant will accede to such a settlement demand but will reject any larger demand.

III. Alternative Legal Systems

Shavell (1982) discusses four alternative allocations of litigation costs: (1) the American system, in which each party bears his or her own costs ($k_{DD} = k_{DP} = c_d$ and $k_{PP} = k_{PD} = c_p$); (2) the British system, in which the loser bears all the costs ($k_{DD} = k_{PP} = 0$ and $k_{DP} = k_{PD} = c_d + c_p$); (3) the system favoring the defendant, in which the defendant bears his or her own costs if the plaintiff wins, but the plaintiff bears all costs if the defendant wins ($k_{DD} = 0$, $k_{DP} = c_d$, $k_{PP} = c_p$, and $k_{PD} = c_d + c_p$); and (4) the system favoring the plaintiff, in which the plaintiff bears his or her own costs if the defendant wins, but the defendant bears all costs if the plaintiff wins ($k_{DD} = c_d$, $k_{DP} = c_d + c_p$, $k_{PP} = 0$, and $k_{PD} = c_p$).

Denote the dependence of the equilibrium strategies and beliefs upon the legal system by a subscript $i = A, B, P$ or D (American, British, favoring the plaintiff, or favoring the defendant): $p_i^*(S)$, $s_i^*(d)$, $b_i^*(S)$, \underline{S}_i , \bar{S}_i .

It is straightforward to show that the following comparative statics results hold for allocation systems (1)-(4) above. For $S \in [\underline{S}_i, \bar{S}_i]$, the equilibrium probability of rejection is an increasing function of the settlement demand S ; since $p_i^{*'}(S) > 0$, the defendant is more willing to go to trial the greater is the plaintiff's settlement demand. Note that p_i^* also depends on π , t , c_d and c_p through \underline{S}_i . Differentiation with respect to the

plaintiff's expected benefit is largely a transfer from the defendant). But it also causes the plaintiff to inflate his or her settlement demand, which has the indirect effect of increasing the likelihood that the demand is rejected. On net, the indirect effect dominates -- even though a trial is less attractive to the defendant, the increased settlement demand forces the dispute into the courts more often.

The following proposition compares the equilibrium policies under these four alternative legal systems.

Corollary 2. The settlement demand policy is greatest under the system favoring the plaintiff, and lowest under the system favoring the defendant. The settlement demand policy under the American system is above, is equal to, or is below that under the British system as π is below, is equal to, or is above $c_D/(c_D + c_P)$. Formally,

- (i) $s_P^*(d) > s_A^*(d) > s_D^*(d)$ for all d ;
- (ii) $s_P^*(d) > s_B^*(d) > s_D^*(d)$ for all d ;
- (iii) $s_A^*(d) = s_B^*(d)$ for all d as $\pi = c_D / (c_D + c_P)$.

Corollary 3. The probability that a given settlement demand is rejected is greatest under the system favoring the defendant and lowest under the system favoring the plaintiff. This probability is smaller than, the same, or greater under the American system as compared to the British system as π is smaller, equal to, or greater than $c_D/(c_D + c_P)$. Formally,

- (i) $p_P^*(S) \leq p_A^*(S) \leq p_D^*(S)$ for all S ;
- (ii) $p_P^*(S) \leq p_B^*(S) \leq p_D^*(S)$ for all S ;
- (iii) $p_A^*(S) = p_B^*(S)$ for all S as $\pi = c_D/(c_D + c_P)$.

Inequalities (i), (ii) and (iii) (for $\pi \neq c_D/(c_D + c_P)$) are strict except at values of S at which the policies being compared are both equal to 0 or 1.

IV. Conclusion

The results of this paper fall into two categories. The first deals with the characterization of equilibrium settlement demand and probability of rejection policies. The model we develop and the results we obtain in this regard are closely related to those of Salant (1984). In fact, the basic problem is exactly the same as his except that we assume a continuum of plaintiff types while he assumes finitely many. The advantage of using a continuum of types is that we are able to obtain closed-form characterizations of the equilibrium strategies, whereas Salant obtains rather complex, recursive characterizations which are relatively hard to interpret. The other advantage of our approach is that we introduce out-of-equilibrium beliefs explicitly. This is especially useful in eliminating various equilibria that depend on perverse expectations (see, for example, the discussion of pooling equilibria in the Appendix and compare it to Salant's footnote 12). The closed-form characterizations also make comparative statics easier and allow us to compare alternative systems for the allocation of direct litigation costs. This comparison gives us our second category of results.

It is surprising that when one considers the probability of using the court (or any third-party dispute resolution mechanism) as a function of

damages, the allocation of direct litigation costs is irrelevant. Although this result is likely to be sensitive to our assumption of risk neutrality, it contrasts sharply with that of Shavell (1982), who (under the same assumption) concludes that the allocation of litigation costs materially influences the likelihood of trial. The difference in results stems largely from Shavell's additional assumption that a dispute will be settled outside the court whenever there exists a settlement amount which makes both parties better off than going to trial. When the settlement process is made endogenous and the defendant is allowed to use the settlement demand to infer information about the plaintiff, the outcome is dramatically changed.

Other authors have considered the effect of different allocations of litigation costs on the likelihood of trial; in particular, both P'ng (1983b) and Bebchuk (1984) find that a shift from the American to the British system for allocating litigation costs increases the likelihood of trial. However, the results of P'ng and Bebchuk are less directly comparable to ours than those of Shavell since, as we indicated in the introduction, they model the settlement and litigation problem quite differently than we do.

We also find that some comparative statics of the equilibrium probability of trial $\hat{p}(d)$ are reversed from the partial-equilibrium comparative statics of the equilibrium strategy $p^*(S)$. In both cases increases in direct litigation costs reduce the probability of using the court. However, an increase in the expected return to the plaintiff from using the court decreases the equilibrium strategy $p^*(S)$, but increases the probability $\hat{p}(d)$ that the court will be used, even though it is the defendant who ultimately makes that decision.

Other variations and applications of this model may be of interest. For example, if one assumes the parties are risk averse, the allocation of

litigation costs might well influence the equilibrium likelihood of trial. An analysis of this case might provide the basis for a welfare comparison of alternative systems. The pre-trial bargaining process could also be generalized. In this paper, as well as the existing literature, one party is given the right to make a final settlement demand, and, inevitably, this settlement demand is such that the other party is indifferent to settling out of court or going to trial. A more sophisticated and realistic specification of the bargaining process seems a minimal prerequisite for an analysis of juridical policy issues. In terms of other applications, one could also use this methodology to analyze breach of contract disputes when the level of losses to the breached party is uncertain. The latter can demand a settlement from the breaching party or use the court. This will affect both parties' incentives in a way that has not been taken into account in the existing literature.

APPENDIX

Proof of Theorem 1.

The proof consists of two parts. In the first part, we show that (b^*, p^*, s^*) is a separating equilibrium. In the second part, we argue that (modulo out-of-equilibrium beliefs) it is the only separating equilibrium.

Part I (Equilibrium) The proof consists of three steps. We show that (1) given $b^*(S)$, $p^*(S)$ maximizes $\Pi_D(S, \rho; b^*)$; (2) given $p^*(S)$, $s^*(d)$ maximizes $\Pi_P(d, S; p^*)$; and (3) $b^*(s^*(d)) = d$ for all $d \in [\underline{d}, \bar{d}]$. It should be apparent from the proof that the out-of-equilibrium beliefs specified in Theorem 1 are not crucial to the argument.

Step (1). For $S \in [\underline{S}, \bar{S}]$, $b^*(S) = (S - \pi k_{DP} - (1 - \pi)k_{DD})/\pi(1 + t)$. Thus

$$\begin{aligned}\Pi_D(S, \rho; b^*) &= \rho[w_D - \pi(1 + t)b^*(S) - \pi k_{DP} - (1 - \pi)k_{DD}] + (1 - \rho)[w_D - S] \\ &= w_D - S, \text{ independent of } \rho.\end{aligned}$$

Consequently, $p^*(S)$ as described in Theorem 1 is optimal for $S \in [\underline{S}, \bar{S}]$ (although not uniquely so).

For $S > \bar{S}$, $b^*(S) = \bar{d}$, so

$$\Pi_D(S, \rho; b^*) = \rho[w_D - \pi(1 + t)\bar{d} - \pi k_{DP} - (1 - \pi)k_{DD}] + (1 - \rho)[w_D - S].$$

Since $w_D - \pi(1 + t)\bar{d} - \pi k_{DP} - (1 - \pi)k_{DD} > w_D - S$ if $S > \bar{S}$, $p^*(S) = 1$ is optimal for $S > \bar{S}$.

Finally, for $S < \underline{S}$, $b^*(S) = \underline{d}$, and

$$\Pi_D(S, \rho; b^*) = \rho[w_D - \pi(1 + t)\underline{d} - \pi k_{DP} - (1 - \pi)k_{DD}] + (1 - \rho)[w_D - S].$$

Since $w_D - \pi(1+t)d - \pi k_{DP} - (1-\pi)k_{DD} < w_D - S$ for $S < \underline{S}$, $p^*(S) = 0$ is optimal for $S < \underline{S}$.

Step (2). Recall that

$$\Pi_P(d, S; p^*) = p^*(S)[w_P - d + \pi(1+t)d - \pi k_{PP} - (1-\pi)k_{PD}] + (1 - p^*(S))[w_P - d + S].$$

Demands $S > \bar{S}$ are dominated by \bar{S} , since $\Pi_P(d, \bar{S}; p^*) - \Pi_P(d, S; p^*) = (1 - p^*(\bar{S}))[\pi(1+t)(\bar{d} - d) + c_D + c_P] > 0$ for $S > \bar{S}$. Moreover, demands of $S < \underline{S}$ are dominated by \underline{S} , since $\Pi_P(d, S; p^*) = w_P - d + S$ for $S \leq \underline{S}$. Thus for any $d \in [\underline{d}, \bar{d}]$, it follows that $s^*(d) \in [\underline{S}, \bar{S}]$. For S in this interval, $p^*(S)$ is twice differentiable, with $p^{*'}(S) = e^{g(S)}/(c_P + c_D)$ and $p^{*''}(S) = -e^{g(S)}/(c_P + c_D)^2$, where $g(S) = -(S - \underline{S})/(c_P + c_D)$. Differentiating $\Pi_P(d, S; p^*)$ with respect to S and equating to zero gives

$$\begin{aligned} \partial \Pi_P / \partial S &= p^{*'}(S)[\pi(1+t)d - \pi k_{PP} - (1-\pi)k_{PD} - S] + 1 - p^*(S) \\ &= e^{g(S)}[\pi(1+t)d - \pi k_{PP} - (1-\pi)k_{PD} - S]/(c_P + c_D) = 0, \end{aligned}$$

or $S = s^*(d) \equiv \pi(1+t)d + \pi k_{DP} + (1-\pi)k_{DD}$. Since

$$\partial^2 \Pi_P(d, s^*(d); p^*) / \partial S^2 = -e^{g(s^*(d))}/(c_P + c_D) < 0,$$

$S = s^*(d)$ provides a local maximum for Π_P . But since this is the only stationary point of Π_P on $[\underline{S}, \bar{S}]$, it must also (uniquely) provide the global maximum.

Step (3). Clearly $b^*(s^*(d)) = d$ for all $d \in [\underline{d}, \bar{d}]$.

Part II (Uniqueness)

To see that no other separating equilibrium exists (modulo out-of-equilibrium beliefs — see the discussion immediately following Theorem 1), first note that $s^*(.)$ must be monotone increasing. If it were not monotone, it would not separate types; if it were monotone decreasing, then optimally $p^*(.)$ must be non-decreasing — since $s^*(.)$ signals true damages d , lower settlement demands are always more attractive to the defendant. But if $p^*(.)$ is non-decreasing, then $s^*(.)$ decreasing cannot be optimal for the plaintiff because as d rises the payoff from trial rises, while the settlement demand $s^*(d)$ falls and is at least as likely to be met. Thus $s^*(.)$ must be monotone increasing; let \underline{s}^* and \bar{s}^* denote the lowest and highest demands made under $s^*(d)$.

The fact that $s^*(.)$ is increasing implies that $p^*(.)$ must also be monotone increasing on $[\underline{s}^*, \bar{s}^*]$, except where $p^*(S) = 1$. To see this, first suppose there exist S_1 and S_2 in $[\underline{s}^*, \bar{s}^*]$ with $S_1 < S_2$, such that $p^*(S_1) = p^*(S_2) < 1$. Then the type d_1 for whom $s^*(d_1) = S_1$ would strictly prefer to demand S_2 . Next suppose that $p^*(.)$ were monotone decreasing on some interval $[S_1, S_2]$ in $[\underline{s}^*, \bar{s}^*]$. Then all types d with $s^*(d) \in [S_1, S_2]$ would strictly prefer to demand S_2 . Thus $p^*(S)$ is monotone increasing on $[\underline{s}^*, \bar{s}^*]$ except possibly for a flat portion on an interval $[\hat{S}, \bar{s}^*]$ where $p^*(S) = 1$. This means that $p^*(S) \in (0, 1)$ for all $S \in (\underline{s}^*, \hat{S})$.

By equation (1), $p^*(S) \in (0, 1)$ for all $S \in (\underline{s}^*, \hat{S})$ implies that $s^*(d) = \pi(1+t)d + \pi k_{DP} + (1-\pi)k_{DD}$, so $\underline{s}^* = \underline{S}$ as defined in Theorem 1. Since expected damages are (at least) \underline{d} when a demand below \underline{S} is made, $\partial \Pi_P / \partial p < 0$, so that $p^*(S) = 0$ for all demands $S < \underline{S}$. Next note that $p^*(S)$

must be continuous from below for $S \in [\underline{S}, \bar{s}^*]$, for any jump must be upward, and an upward jump at, say, S_1 would cause type d_1 such that $s^*(d_1) = S_1$ to strictly prefer a report of $S_1 - \varepsilon$ for sufficiently small ε . In particular, this argument implies that $p^*(\underline{S}) = 0$. Continuity of $p^*(S)$ implies that $p^*(S)$ is differentiable almost everywhere on $[\underline{S}, \bar{s}^*]$.

If $p^*(S)$ is differentiable at $S \in [\underline{S}, \hat{S}]$, then equations (2) and (3) must both hold; hence (5) must hold almost everywhere on $[\underline{S}, \hat{S}]$. Then for S in this interval, $p^*(S) = 1 + \alpha \exp\{-S/(c_D + c_P)\}$, where the continuity of $p^*(\cdot)$ across any possible points of non-differentiability ensures that the same constant α applies; that is, $p^*(S)$ is differentiable on $[\underline{S}, \hat{S}]$ (where left- and right-hand derivatives are used at \underline{S} and \hat{S} , respectively).

We have already argued that the boundary condition $p^*(\underline{S}) = 0$ is necessary, so $p^*(S) = 1 - \exp\{-(S - \underline{S})/(c_D + c_P)\}$. Thus there is no $\hat{S} \leq \bar{s}^*$ at which $p^*(S) = 1$; hence $\bar{s}^* = \bar{S}$ as described in Theorem 1. Any demand $S > \bar{S}$ has associated with it expected damages of (no greater than) \bar{d} , so $\partial \Pi_D / \partial p > 0$, implying $p^*(S) = 1$ for all $S > \bar{S}$. This upward jump in $p^*(\cdot)$, which occurs just after \bar{S} , is permissible in equilibrium because (in equilibrium) no plaintiff demands $S > \bar{S}$; thus there are no plaintiffs who would be tempted by this jump to demand less.

Pooling Equilibria

Suppose all plaintiffs settle at some S^* . Then it must be the case that $\pi(1+t)E(d) + \pi k_{DP} + (1-\pi)k_{DD} \geq S^* \geq \pi(1+t)\bar{d} - \pi k_{PP} - (1-\pi)k_{PD}$; that is, the defendant must prefer S^* to trial and all plaintiff types (in particular, the one with the highest damage level) must also prefer S^* to trial. Such an S^* exists if and only if $\bar{d} - E(d) \leq (c_D + c_P)/\pi(1+t)$. The problem is to find out-of-equilibrium beliefs, $E_\mu(d|S)$ for $S \neq S^*$, which

support this as an equilibrium. Since $S^* \geq \pi(1+t)E(d) + \pi k_{DP} + (1-\pi)k_{DD}$, we can set $p(S^*) = 0$. Then regardless of $E_\mu(d|S)$ for $S < S^*$, no plaintiff will ever demand a settlement less than S^* . In particular, if $E_\mu(d|S) = E(d)$ for $S < S^*$, then $p^*(S) = 0$ for $S < S^*$ is optimal for the defendant and S^* will dominate any $S < S^*$ for the plaintiffs.

The situation for $S > S^*$ is more complicated. For a plaintiff of type d , S^* will dominate any $S > S^*$ if and only if $p^*(S) > (S - S^*)/[S - \pi(1+t)d + \pi k_{PP} + (1-\pi)k_{PD}]$. This constraint is feasible since by the definition of S^* , the right-hand side is less than 1. But the defendant will be willing to set $p^*(S) > 0$ for $S > S^*$ if and only if $E_\mu(d|S) \leq (S - \pi k_{DP} - (1-\pi)k_{DD})/\pi(1+t)$. If $E_\mu(d|S) = E(d)$ for all $S > S^*$, then this constraint will hold for all $S > S^*$ if and only if $E(d) \leq (S^* - \pi k_{DP} - (1-\pi)k_{DD})/\pi(1+t)$, or $\pi(1+t)E(d) + \pi k_{DP} + (1-\pi)k_{DD} \leq S^*$. But we require $\pi(1+t)E(d) + \pi k_{DP} + (1-\pi)k_{DD} \geq S^*$ in the definition of S^* . So in this case, the only possible value for S^* is $S^* = \pi(1+t)E(d) + \pi k_{DP} + (1-\pi)k_{DD}$. In this case, for any $S > S^*$, $p^*(S) = 1$, so it will indeed support an equilibrium. If $S^* < \pi(1+t)E(d) + \pi k_{DP} + (1-\pi)k_{DD}$, pooling equilibria are still possible so long as $E_\mu(d|S) \leq (S - \pi k_{DP} - (1-\pi)k_{DD})/\pi(1+t)$. But for S "close" to S^* this requires $E_\mu(d|S) < E(d)$; in other words, if the defendant sees a settlement demand greater than S^* but not too high, he or she must believe this came from a plaintiff type with true damages less than the average. These "perverse" beliefs are possible but unlikely, so the most natural pooling equilibrium is the one in which $E_\mu(d|S) = E(d)$ and $S^* = \pi(1+t)E(d) + \pi k_{DP} + (1-\pi)k_{DD}$. Recent work by Banks and Sobel (1985) suggests that pure pooling equilibria which rely on such "perverse" beliefs fail to satisfy a desirable stability condition.

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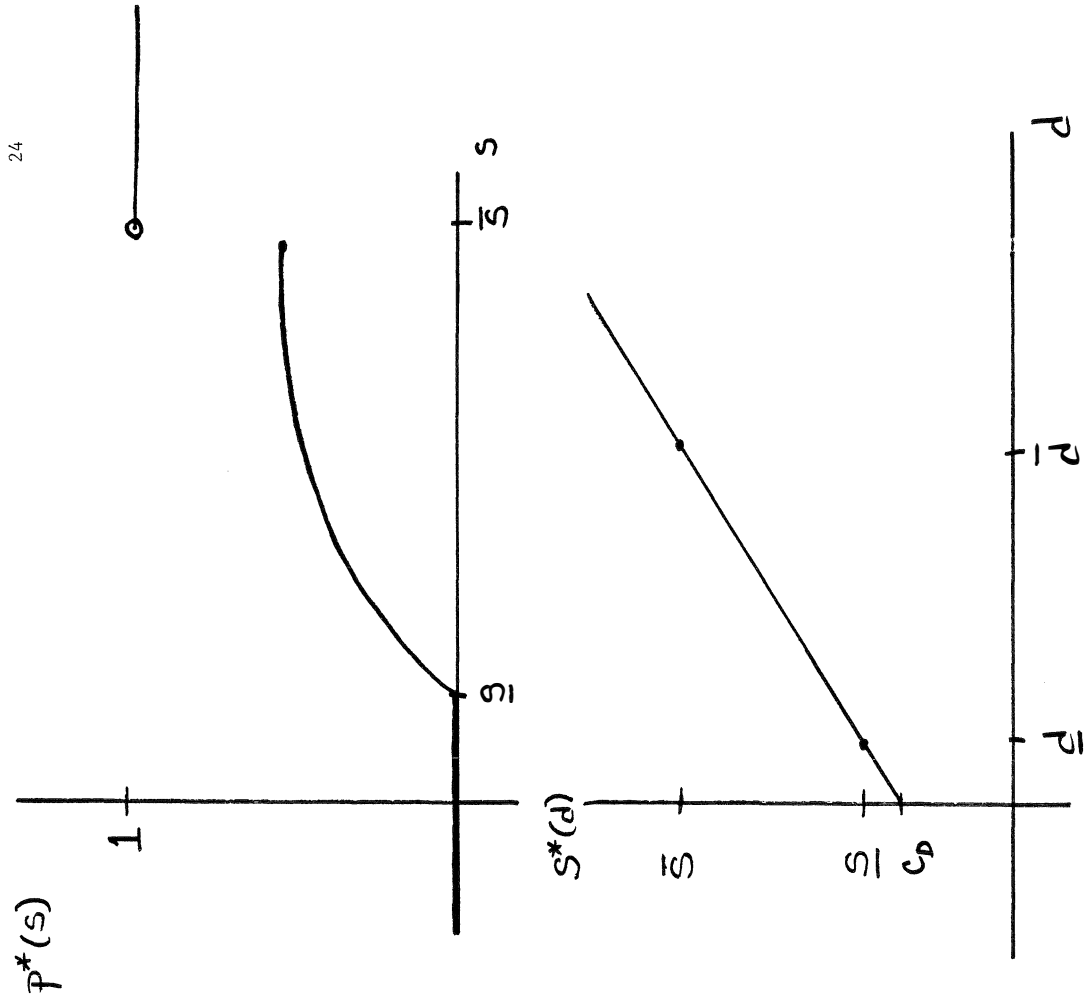


Figure 1